New Directions for Managing Washington State Seagrass Resources

Elsa L. Carlisle, Sandy Wyllie-Echeverria *and* ***Terrie Klinger***
University of Washington

Abstract
Seagrass is an essential component of coastal marine ecosystems in the northeastern Pacific, where it has substantial ecological, economic and cultural value, and where it is a focal species for scientific study and natural resource management. Seagrass is threatened by both natural and anthropogenic disturbances, and recent reports have shown a decrease in seagrass abundance globally.

Two genera and five species of seagrass grow in the waters of Washington State. In the Puget Sound, threats to seagrass include but are not limited to dock construction, dredging and filling, and loss of water quality due to sediments and contaminants. Despite the need for management, Washington State presently lacks a formal seagrass management policy. In this paper we review existing seagrass management programs and suggest strategies for management program development in Washington state.

Introduction
Seagrasses are a vital component of coastal marine ecosystems providing ecological, economic and cultural value. Seagrasses are threatened by both natural and anthropogenic disturbances. To date, large-scale declines in seagrasses at more than 40 locations worldwide have been documented (Hemminga and Duarte 2000), and over 90,000 ha of seagrasses were lost worldwide from 1986-1996 (Short and Wyllie-Echeverria 1996). Six species of seagrass grow in the waters of Washington State: *Zostera marina, Z. japonica, Phyllospadix scouleri, P. torreyi and P. serrulatus* and *Ruppia maritima.* Threats to Washington seagrasses include but are not limited to dock construction, shoreline modification, dredging and filling, heavy metal toxicity, aquaculture and the reduction of water clarity either by suspended sediments or eutrophication. Despite the need for management, Washington State presently lacks a formal seagrass management or conservation policy. In this paper we review existing seagrass management programs for the state of Texas, the state of Florida, and the Chesapeake Bay. We draw on these programs as models to suggest future actions for Washington State to protect seagrass resources. We also analyze Washington's progress towards the development of a statewide seagrass conservation and management plan.

Seagrass Conservation Plan for Texas
Research conducted by the Texas Parks and Wildlife Resource Protection Division (TPW) in the early 1990s showed evidence of extensive damage caused by boat and propeller scarring in many of the seagrass beds in Texas bays. This led to early efforts for coordination and discussions with other state agencies, university scientists, and maritime industry representatives, revealing that additional threats might be damaging the seagrasses in Texas. Causal factors identified include reductions in water clarity and dredging. Increased awareness of the relationship between human activities and seagrass loss convinced stakeholders that a workshop focused on the development of a Seagrass Conservation Plan was necessary. Original sponsorship for the planning effort came from three state agencies (TPW, Texas General Land Office (TGLO) and Texas Natural Resource Conservation Commission (TNRCC)). The National Estuary Programs in Galveston and Corpus Christi, affiliated with TNRCC were also involved in planning the workshop. Workgroups were assembled from natural resource agencies, universities and industry to focus on three main issues: Research, Management, and Public Outreach/Education. Collectively they developed a conceptual draft outlining major issues, goals, objectives, and actions. In 1996 a preliminary draft was presented for public review and comment at a two-day symposium, attended by 100 scientists, resource managers, planners, industry representatives and citizens. Recommendations and inputs from the symposium were used to revise and expand the document into a formal plan (Texas Parks and Wildlife 1999). It is envisioned that "the strategies and recommendations of the plan will be implemented by the appropriate agencies, universities and non-governmental organizations over a 5 to 10 year horizon" (TPW 1999).

Seagrass Management in Florida
The of Florida does not currently have a formal statewide conservation or management plan for seagrass, although such a plan is currently being developed. A seagrass management plan has been developed for Big Lagoon and Santa Rosa Sound based on the Seagrass Conservation Plan for Texas (Florida Department of Environmental Protection 2001). Also, attention is given to seagrass in various management programs throughout the state. The Comprehensive Conservation and Management Plans for each of the four Florida estuaries in the National Estuary Program (NEP) address seagrass

as a resource needing monitoring and protection, primarily in terms of water quality and boat propeller scarring. For example, the Tampa Bay Estuary Program developed a regional, multi-governmental seagrass-monitoring program including annual assessments of seagrass extent, zonation and changes in growth and distribution (Potter 2002). In addition, the Indian River Lagoon Program focus on the improvement of water and sediment quality to support a healthy seagrass-based estuarine ecosystem and the restoration and enhancement of seagrass beds as a functioning ecosystem (Indian River Lagoon National Estuary Program 1996).

In 1999, it was recognized that numerous programs and initiatives existed to restore, conserve, protect and manage Florida's waters and associated ecosystems. However, little or no coordination existed between these projects, which commonly overlapped in goals and efforts, and although some had been successful, the overall condition of Florida's waterways continued to decline. As a result, the Florida Forever Act was enacted (Fla. Stat. 373.199) to integrate and coordinate existing efforts, challenging each water management district to develop a 5-year work plan identifying projects in their areas. The act also details what information should be included in a project work plan including a description of the water body system, an identification of governmental jurisdiction in the area, current land use, strategies for restoration or protection, state of knowledge of the system, and a description of measures needed to mange and maintain the system after restoration. A schedule for restoration including a funding estimate, performance measures, and permitting and regulatory issues are also to be included in a project work plan. Although Florida Forever does not focus specifically on seagrass, the concepts laid out in this plan could be utilized for seagrass management and conservation plans.

Chesapeake Bay Submerged Aquatic Vegetation Policy

In 1983 it was recognized that there was a decline in the living resources of the Chesapeake Bay and that a cooperative approach was needed to share the responsibilities of managing this ecosystem. The State of Maryland, the Commonwealths of Pennsylvania and Virginia, the District of Columbia, and the Environmental Protection Agency (EPA) signed the 1983 Chesapeake Bay Agreement to facilitate cooperative management (Chesapeake Executive Council 1983). The revised agreement signed in 1987 sets forth the goal "to provide for the restoration and protection of the living resources their habitats and ecological relationships" and the objective to "restore, enhance, protect and manage submerged aquatic vegetation" including seagrasses (CEC 1987). In an effort to meet these goals the Submerged Aquatic Vegetation Policy for the Chesapeake Bay and Tidal Tributaries was adopted in 1989 (CEC 1989). The goal of the policy is to achieve a net gain in submerged aquatic vegetation distribution, abundance and species diversity. The Submerged Aquatic Vegetation Workgroup, under the direction of the Chesapeake Bay Program's Living Resources Subcommittee developed the Implementation Plan for the Submerged Aquatic Vegetation Policy detailing the actions to achieve the Policy's goals (CEC 1990). The plan is organized into five areas of emphasis: resource assessment, protection of existing submerged aquatic vegetation, restoration of submerged aquatic vegetation, education, and research. Each section includes a list of appropriate actions, a review of current programs and a table of tasks designed to implement each of the Policy's action items identifying the responsible agency and a schedule for completion.

Blueprint for a Seagrass Management and Conservation Plan for Washington State

The threats to seagrass and the extensive losses that have been documented worldwide clearly indicate the need for management and the implementation of policies to ensure the sustainability of these valuable resources. Management plans, such as the Seagrass Conservation Plan for Texas (TEX), the Seagrass Management Plan for Big Lagoon and Santa Rosa Sound (BLSRS), and the Implementation Plan for Submerged Aquatic Vegetation Policy (IPSAV) can be valuable tools to integrate and coordinate management efforts to promote efficiency and success. These plans, along with the Florida Forever Act and the Chesapeake Bay Agreements address many necessary components to successful seagrass management and planning. Ideas and concepts have been taken from each to be used as a blueprint for successful seagrass management in areas where seagrasses are threatened. Such a plan addresses four main focus areas: (1) Seagrass Assessment, (2) Seagrass Management and Policy, (3) Seagrass Research and (4) Environmental Education/Outreach. In this way, the main focus areas of the existing plans are fully addressed (Research, Management and Environmental Awareness (TEX, BLSRS) and Assessing the Resource, Protection of Existing SAV, Restoration of SAV, Education and Information, and Research (IPSAV)).

Seagrass Assessment, although not specifically addressed as a main focus area in the Texas and Florida plans, is given attention in the Implementation Plan for SAV. Successful seagrass management and conservation needs to begin with assessment of the resource including knowledge of the distribution and abundance of seagrasses (Wyllie-Echeverria et al 1995). This also includes an assessment of the current status and temporal trends in species composition. Biotic and abiotic parameters such as estimates of abundance, percent cover and density of individual species, epiphyte load, water clarity and substrate type should be considered in a monitoring program (Neckles 1994). Continued monitoring

is important to detect biological and environmental trends to aid in proper management (Phillips 1984). The history of the change of the area needs to be described (CEC 1990) including the history of uses, disturbances (both natural and anthropogenic) and historical distributions of seagrass (FL Stat. 373.199(4)(a)). This is commonly overlooked in management plans, but is important to determine where seagrasses grew historically and to determine their vertical range of variability. The ecological and economic value of seagrass to the area needs to be assessed, along with the cultural value of seagrass (Wyllie-Echeverria and Cox 2000), also commonly overlooked in existing plans. Natural and anthropogenic threats to seagrasses need also be described.

Seagrass Management and Policy, Seagrass Research, and Education and Outreach are each addressed in all three plans. Seagrass Management and Policy includes an identification of all government and non-government units that have jurisdiction in the area and a review and evaluation of effectiveness of existing regulations and management programs (CEC 1990). This can help identify and eliminate conflicting authorities and integrate and coordinate management efforts to increase efficiency and cooperation (Fresh 1994, Pawlak 1994).

The sections in each plan devoted to Seagrass Research describe both short and long-term research priorities (CEC 1990) as well as describe the current biological knowledge of seagrass systems in the area. The ability to successfully manage seagrasses depends on an understanding of seagrass productivity in relation to changes in light, nutrient and temperature regimes (TPW 1999) as well as a general knowledge of the basic biology and variability in its distributional patterns (Phillips 1984, Simenstad 1994).

Public Education and Outreach can often be more successful than regulation in achieving conservation and restoration of seagrasses (TPW 1999). The sections describing seagrass Public Education and Outreach encourage federal state and local agencies to develop and distribute educational and informational materials concerning the importance of seagrasses and detail efforts aimed at its protection and restoration (CEC 1990). The primary goal of environmental education and outreach is to utilize education and outreach to promote stewardship (TPW 1999), by providing the public with a better understanding of the importance of seagrass ecosystems and how human activities affect these systems (Florida Department of Environmental Protection 2001). The Texas plan lays out five steps to achieve environmentally responsible behavior: develop awareness, foster understanding, create concern, teach skills, and encourage responsible behavior (TPW 1999).

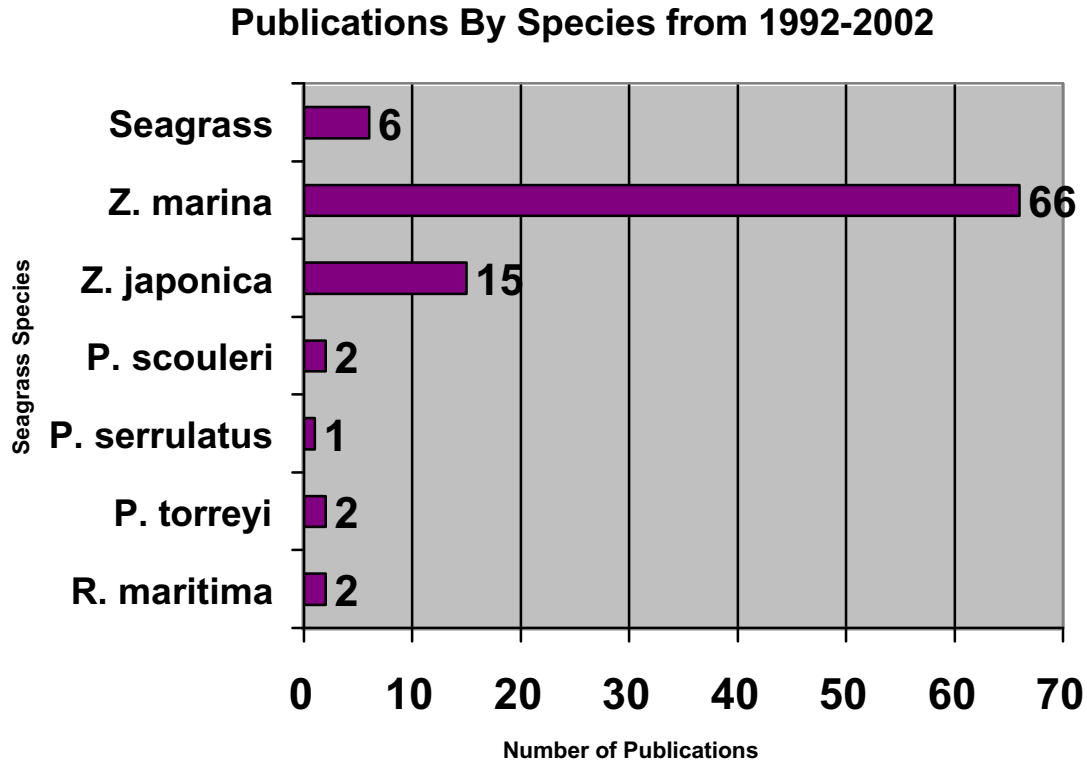
Washington State's Progress Towards a Seagrass Conservation and Management Plan

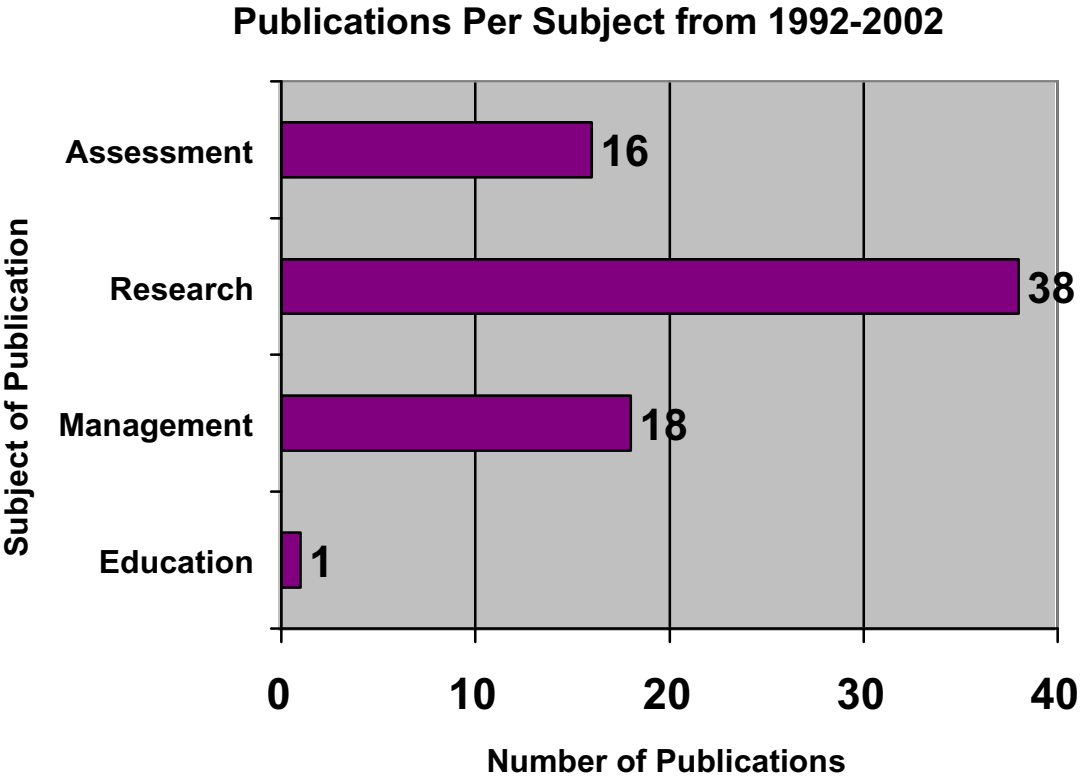
A bibliometric survey was conducted to determine what research has been done in Washington State to address the four areas of concentration described above. A bibliometric literature review was conducted based on a method used by Duarte (1999). Databases searched included the Aquatic Science and Fisheries Abstracts, BIOSIS (biological abstracts), NTIS (government reports) and the Cascade database which searches seven Washington State university libraries. The abstracts were searched for publications on seagrasses in Washington State from 1992 to 2002. Seventy-two publications were found.

The abstracts were classified according to the seagrass species discussed in the publication. Here, the general classification for "seagrass" refers to those publications that discussed seagrasses in general and did not discuss a specific species.

The research has been largely biased towards *Z. marina* with 66 of the 72 publications discussing *Z. marina,* 15 publications discussing *Z. japonica*, and only one or two publications discussing the other species. This reflects the research priority given to species involved in mitigation. *Phyllospadix* species grow on wave-swept, rocky areas where development is less likely to occur. *Z. marina* and *Z. japonica* are more likely to be impacted by development and are commonly involved in mitigation projects.

The publications were further classified according to their subject using the four areas of concentration described above (Assessment, Management, Research, and Public Education and Outreach). This was done to identify gaps and to determine areas needing more emphasis. The majority of the publications focused on research, including physiology and habitat value. Eighteen publications focused on management including reviews of current policies, mitigation techniques and restoration projects. Sixteen publications focused on assessment including seagrass mapping and distribution and one publication focused on public participation and education.


Publications By Species from 1992-2002
Seagrass Species
Seagrass
Z. marina
Z. japonica
P. scouleri
P. serrulatus
P. torreyi
R. maritima
6
66
15
2
1
2
2
0
10
20
30
40
50
60
70
Number of Publications


Publications Per Subject from 1992-2002
Subject of Publication
Assessment
Research
Management
Education
16
38
18
1
0
10
20
30
40
Number of Publications

Seagrass Assessment

The majority of the seagrass publications concentrating on seagrass assessment discussed only *Z. marina*. For example, the majority of publications on seagrass distribution showed only distribution for *Z. marina*, leaving a large data gap for other seagrass species. Further, little was discussed about the historical distribution of seagrasses in Washington State. Historical distribution is important to aid management (Wyllie-Echeverria et al. 1995). A lack of comprehensive historical data sets can hinder the analysis of changes over time (Thom and Hallum 1990).

The value of seagrasses was mainly discussed in relation to ecological value. However, seagrasses also have economic (McRoy and Williams-Cowper 1979) and cultural value (Wyllie-Echeverria et al. 2000), both of which were discussed very little in the literature.

Seagrass Research

Of the publications focusing on seagrass research, all 38 discussed *Z. marina*, although 6 also discussed *Z. japonica*. Again, the literature was largely biased towards *Z. marina*. Not one research publication was found on the three *Phyllospadix* species in Washington State. This is important to note because *Phyllospadix scouleri, torreyi*, and *serrulatus* are endemic to the west coast (Phillips and Menez 1988), yet there has been very little published about them in Washington, leaving a huge data gap. Research is needed to describe the basic biological and physiological functions of these species in Washington to gain a comprehensive understanding before management can be discussed (Wyllie-Echeverria and Thom 1994). Other data gaps in the literature noticed were: impacts of aquaculture on seagrass, long-term effects of decreasing water quality, and removal and recovery experiments.

Seagrass Management

Eighteen publications focused on areas of seagrass management. Nine publications dealt with issues of mitigation focusing again primarily on *Z. marina*, and most dealt with issues relating to over-water structures. Four publications focused on restoration, and transplantation, and again focused only on *Z. marina* and five analyzed current seagrass policy and management programs in Washington State. A data gap identified was how to manage species other than *Z. marina*, for example, how to manage the non-native *Z. japonica* species. Under the Washington Hydraulics Code, Z. *japonica* is protected, however little was published regarding whether managers should continue to protect it or eradicate it as other coastal states have chosen to do. Further studies of the potential impacts of the nonnative species on native ecosystems need to be conducted to aid management decisions (Pawlak 1994).

Public Education and Outreach

The literature published on education and public awareness, again focused primarily on *Z. marina*. It is important to increase the public's awareness of all the species growing in Washington State. When increasing the public's involvement and awareness of seagrasses it is important to consider the nature of the uses of the nearshore in Washington State. The water is colder than in Texas and Florida, the seagrass grows in a much narrower band, and in some cases grows on private property or in deeper water requiring SCUBA equipment to access the sites. These factors must be considered when involving the public in restoration or monitoring projects.

Conclusion

It is recommended that the new direction for managing seagrasses in Washington State moves towards an interagency seagrass conservation and management plan, based on those existing in other coastal states and addressing the four focus areas of (1) Seagrass Assessment, (2) Seagrass Research, (3) Seagrass Management, and (4) Public Education and Outreach. The bibliometric survey conducted shows progress in the last decade to address these focus areas in Washington State, as well as identifies data gaps needing to be filled.

An interagency statewide plan can increase collaboration at a regional scale and strengthen the like between research and management.

References

Chesapeake Executive Council. 1983. *1983 Chesapeake Bay Agreement.* Chesapeake Bay Program, Annapolis, MD.

Chesapeake Executive Council. 1987. *1987 Chesapeake Bay Agreement.* Chesapeake Bay Program, Annapolis, MD.

Chesapeake Executive Council. 1989. *Submerged Aquatic Vegetation Policy for the Chesapeake Bay and Tidal Tributaries*. Chesapeake Bay Program Agreement Commitment Report. Annapolis, MD.

Chesapeake Executive Council. 1990. *Implementation Plan for the Submerged Aquatic Vegetation Policy*. Chesapeake Bay Program. Annapolis, MD.

Duarte, Carlos, M., 1999. Seagrass ecology at the turn of the millennium: challenges for the new century. Aquatic Botany 65 pp. 7-20.

Florida Department of Environmental Protection. 2001. *Seagrass Management Plan for Big Lagoon and Santa Rosa Sound*. Ecosystem Restoration Section. Pensacola, FL.

Fresh, Kurt. 1994. Seagrass management in Washington State. In: Wyllie-Echeverria, S., A.M. Olsen and M.J. Hershman (Eds.) Seagrass science and policy in the Pacific Northwest: Proceedings of a seminar series. (SMA 94-1). EPA 910/ R-94-004. 63 pp.

Hemminga, Marten, A. and Carlos M. Duarte. 2000. Seagrass Ecology. University Press: Cambridge. 298pp.

Indian River Lagoon National Estuary Program. 1996. *Indian River Lagoon Comprehensive Conservation and Management Plan.*

McRoy, C.P. and S. William-Cowper. 1979. Seagrasses of the United States: and ecological review in relation to human activities. U.S. Fish and Wildlife Service, Biological Services Program. FWS/OBS-77/80. 283 pp.

Neckles, H. A. 1994. "Ecological Indicators Working Group Report." In H.A. Neckles (Editor), *Indicator Development: Seagrass Monitoring and Research in the Gulf of Mexico* (pages 43-50). U.S. Environmental Protection Agency. Gulf Breeze, FL.

Pawlak, Brian T. 1994. Analysis of the politics and management practices of Washington state agencies as they pertain to the seagrasses, *Zostera marina* and *Zostera japonica*. Report to the Padilla Bay National Estuarine Research Reserve by Brian Pawlak, University of Washington, School of Marine Affairs. 20pp.

Phillips, Ronald C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: A community profile. U.S. Fish and Wildl. Serv. FWS/OBS-84/24. 85pp.

Phillips, Ronald C. and Ernani G. Menez. 1988. Seagrasses. Smithsonian Institution Press: Washington, D.C. pp.104.

Potter, L. (Editor). 2002. *Managing a Lasting Environment 2002 Annual Report*. Pinellas County Department of Environmental Management. Clearwater, FL.

Short, Frederick T., and Sandy Wyllie-Echeverria. 1996. Natural and human-induced disturbance of seagrasses. Environmental Conservation. 23(1): 17-27.

Simenstad, Charles A. 1994. Faunal Associations and Ecological Interactions in Seagrass Communities of the Pacific Northwest Coast. In: Wyllie-Echeverria, S., A.M. Olsen and M.J. Hershman (Eds.) Seagrass science and policy in the Pacific Northwest: Proceedings of a seminar series. (SMA 94-1). EPA 910/R-94-004. 63 pp.

Texas Parks and Wildlife. 1999. *Seagrass Conservation Plan for Texas*. Resource Protection Division. Austin, TX.

Thom, R.M, and L. Hallum. 1990. Long-term changes in the areal extent of tidal marshes, eelgrass meadows, and kelp forests of Puget Sound. FRI-UW-9008, Fish. Res. Inst., University of Washington, Seattle, Washington.

Wyllie-Echeverria, S., Phillips, R.C., Hunn, E.S. Turner, N.J. and Miller, M.L. 1995. Eelgrass as a natural resource: implications for formal policy. Pp. 529-36 *in* Puget Sound Research 95 Proceedings. Puget Sound Water Quality Authority, Olympia, WA.

Wyllie-Echeverria, S., P. Arzel, and P.A. Cox. 2000. Seagrass conservation: lessons from ethnobotany. Pacific Conservation Biology. 5: 329-335.

Wyllie-Echeverria, S. and P.A. Cox. 2000. Cultural saliency as a tool for seagrass conservation. Biolagia Marina Mediterranea 7(2): 421-424.

Wyllie-Echeverria, S. and R.M. Thom. 1994. Managing seagrass systems in western North American: research gaps and needs. Alaska Sea Grant College Program Report No. 94-01. 21pp.